

Impedans Octiv used in a study demonstrating a simple radio-frequency (RF) power-coupling scheme for a micro atmospheric pressure plasma jet*

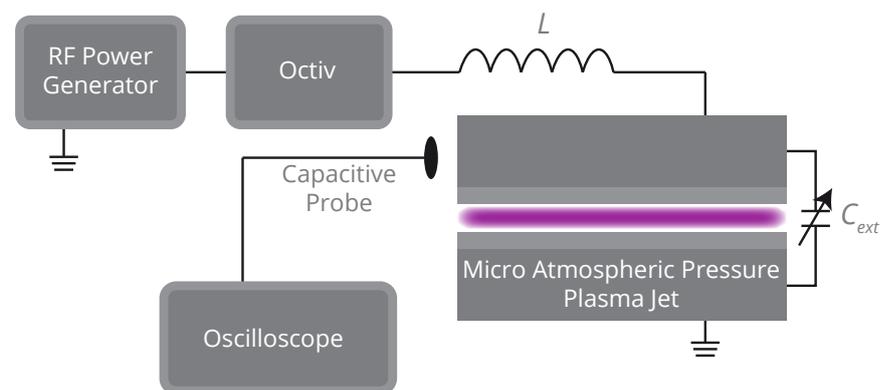
STUDY

There has been a lot of attention in recent times on atmospheric pressure plasmas excited by radio-frequency sources, thanks to new applications, especially in plasma medicine. Schulz von der Gathen's micro atmospheric pressure plasma jet (μ APPJ) in particular has been studied in depth both experimentally and numerically. This abundance of research and the ease of implementation make it a promising plasma source for applications involving plasma interactions with biological materials.

In this paper, the authors demonstrate a simple radio-frequency (RF) power-coupling scheme for a micro atmospheric pressure plasma jet (μ APPJ) based on a series LC resonance, with the discharge gap being part of the resonant element. The Impedans Octiv was used in the experiment.

METHOD:

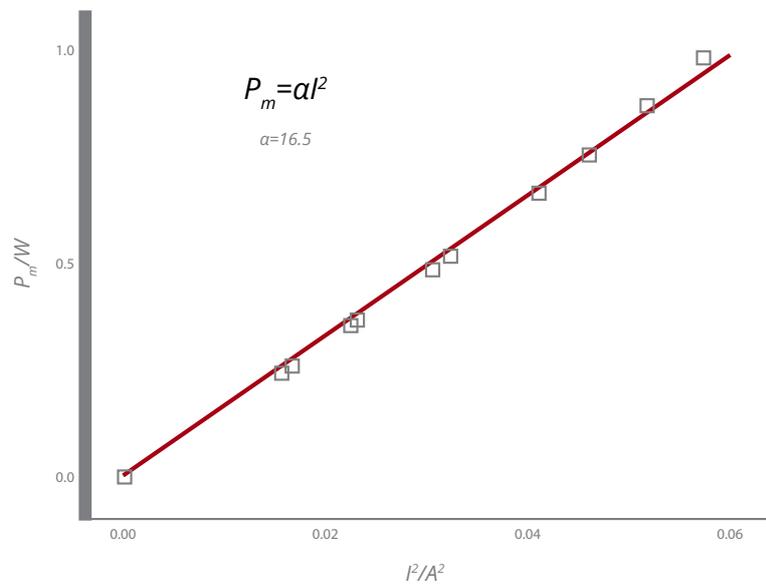
The illustration below shows the experimental setup:



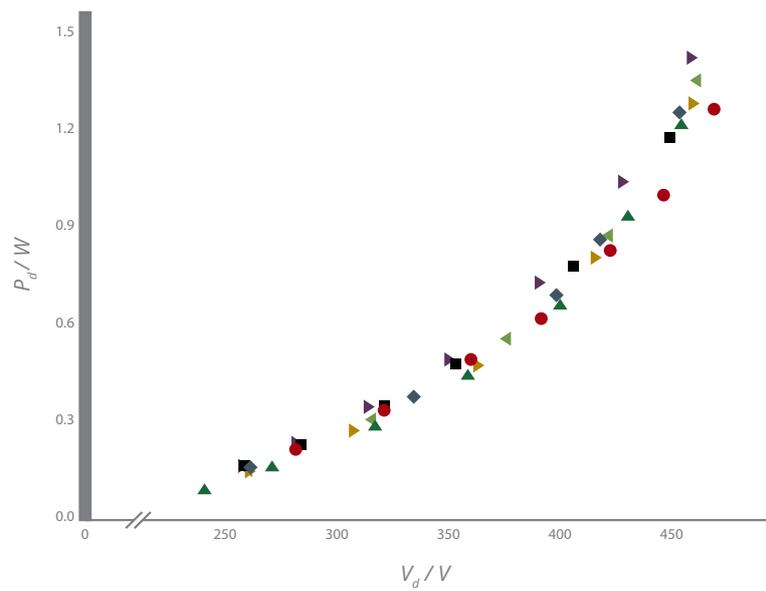
A variable frequency signal generator and a broadband amplifier (50 dB) was used to generate the RF voltage. A tuneable capacitor ($C_{ext} = 2-22$ pF) and an inductor ($L = 16.5$ μ H, Micrometals T68-6 core) were engaged to tune the circuit into resonance at a frequency close to 13.56 MHz. The Impedans Octiv, factory calibrated at 13.56 MHz with a nominal accuracy 2% in the range of 13.56 ± 0.5 MHz, was used to measure the input voltage, current and phase shift before the coupler. In addition, a calibrated capacitive probe was used to measure independently the voltage at the powered electrode. Fan cooling was used to reduce the temperature-related drift of the coupler losses to less than 10%.

FINDINGS:

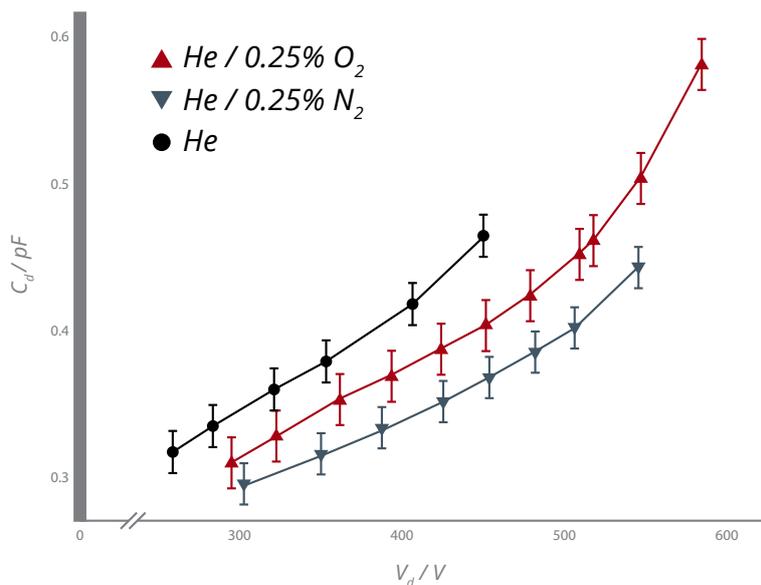
The graph below illustrates the power dissipated in the coupler versus rms current squared:



The following graph illustrates the discharge power as a function of the discharge voltage amplitude. The overall reproducibility of the measurements performed in different runs was about 10%. The different runs are represented by coloured shapes.



The graph below shows that the increase of the discharge power was always linked to an increase of the real part of the total impedance seen by the Octiv system.



The experiment found that the RF generator power required to sustain the discharge was in the range of 1–2 W, which makes the system compact and inexpensive. The high efficiency and simplicity of the coupling circuit allowed the authors to accurately characterize a number of the electrical properties of the micro-discharge: the dissipated power, the effective discharge resistance and capacitance as a function of the applied voltage.

CONCLUSION:

The results from this study are valuable for benchmarking numerical models of the μAPPJ . The authors are now attempting to integrate the device and resonant coupler into a simple transistor circuit, which would enable the whole unit to be powered from a local battery.

REFERENCES

- * D Marinov and N St J Braithwaite.
"Power coupling and electrical characterization of a radio-frequency micro atmospheric pressure plasma jet".
Plasma Sources Sci. Technol. 23 (2014) 062005 (6pp). doi:10.1088/0963-0252/23/6/062005.
Published 9 October 2014.